Stealth CPI: Managing Work Products to Achieve Continuous Process Improvement

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While identifying, defining, and organizing activities into graphical process diagrams is helpful during Continuous Process Improvement (CPI) planning, it's not very useful to our managers and their teams during implementation. Most managers understand—and therefore manage—through work products (WPs). Managing WPs has proven to be simpler and more intuitive than managing processes, dealing directly with the end-products themselves. Stealth CPI centers on existing WPs, permitting organizations to implement process improvement (PI) incrementally, purposefully—and even stealthily.

Most if not all PI standards, models, and methodologies concern themselves with processes during the planning and implementation phases. But when it comes to the evaluation phase, evaluators do not look at processes but at the concrete evidence (artifacts and WPs) showing that the processes have been followed. Nevertheless, PI remains an abstract exercise that is not intuitively obvious to the majority of technical professionals who are not specialists in the PI field. This fact has led to a myriad of models and methodologies that attempt to simplify the concept of PI. The end result has been the creation of an extensive consulting industry dedicated to shepherding organizations through the confusing maze and jargon of formal standards compliance.

In our organization, the Presidential Helicopters Program In-Service Integrated Product Team (VH-IS), we are prototyping a concept that we call Stealth CPI. Our goal is to improve our processes by structuring our WPs so that our people can be best practices- and CMMI-compliant just by doing their jobs. This concept is based on lessons learned from previous implementations of CMMI in other organizations:

1. Process diagrams are abstract and are, at best, graphic representations of activities conducted within and in support of the described process. Thus, process diagrams are tools, not products.
2. Processes are made up of activities, and each activity results in one or more WPs. Only the WP, not the generating activity, can transfer the activity's productivity elsewhere within an organization. Any activity or suite of related activities that does not produce a desirable WP is held suspect because it may be unnecessary or unproductive.

We feel that neither processes nor activities alone benefit organizations. With this in mind, our plan implements CPI by managing WPs instead of processes. Stealth CPI meets its PI goals in three phases:

1. **Planning Phase**
   - Documenting and refining the visual representation of the improved processes.
   - Mapping WPs to activities.
   - Developing work folders (all containing guidance) to support improved WPs.
2. **Implementation Phase**
   - Publishing the work folders.
   - Assigning the improved WPs.
3. **Assessment Phase**
   - Conducting continuous assessments. For example, SCAMPI B and C assessments in a CMMI environment.

Project managers are a breed apart in American business and government. They walk a narrow line defined by requirements, schedule, budget, and resources, complicated by the demands of superiors and the needs of subordinates. Happy is the manager who knows exactly what WPs are required and when, and who has been given all the resources necessary to produce those WPs correctly, completely, and in a timely manner. In fact, the same thing can probably be said of most employees in any organization, regardless of the organization's business.

When the specter of PI rears its intimidating head (as it will eventually in every competitive business), all too frequently the conventional response is to start with process definition in the form of process diagrams. In too many cases, the end result of this classic approach is improved process diagrams instead of improved processes. Giving project managers a process diagram and asking them to make the contained improvements is usually a waste of their time. Training project managers to become PI specialists—in the hope that the *worker bees* will fulfill the desires of the management queens and drones—can be expensive and wasteful. We believe it is more efficient and cost-effective to implement PI by:

- Rolling out improved WP tool sets rather than improved process diagrams.
- Training our people to be experts in our WPs rather than in PI.

And our people agree.

Stealth CPI is a *bottoms-up* approach that takes advantage of a simple fact: It is far simpler and infinitely more intuitive to identify and improve WPs than it is with processes. It is more conceivable to envision a successful organization without a single process diagram than it is to imagine one without WPs. Even the clearest diagram of the best possible process can't single-handedly improve an existing process. This is where PI models and methodologies normally enter the picture: to show us where to go next. Regardless of the standard to be used, all of them start with processes but end with WPs. The reason for this is that assessing the goodness of a process is neither feasible nor objective. Take the following exchange as a typical example:

Evaluator: "Do you conduct peer reviews?" (If peer reviews are part of the standard being evaluated, then "Yes" is the only correct answer to this question).

Evaluee: "Yes."

Evaluator: "Prove it!"

At this point, it is neither correct nor sufficient to reply: "Our next peer review is in two weeks. Come back then and watch."

In other words, the proof lies not in the process, but in the artifacts and WPs that result from the process. Evaluators routinely presume that the existence of a desired artifact proves that its generating activity did, in fact, take place. The quality of the artifact is presumed to reflect the quality of its generating activity.

NAVAIR has developed its "System

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Engineering Guide," which mandates a process of System Engineering Technical Reviews (SETRs) [1]. The SETR entry and exit criteria are more easily understood when they are described as WPs than when they are portrayed as activities. Thus, a standardized report containing the output of the review activities usually makes a more useful exit criterion than a statement that the reviews activities were completed.

Since evaluations are always conducted at the artifact level, it makes sense to approach PI from the same perspective. PI constitutes a chain with connected links from the envisioned process through the implementing activities right down to the artifacts that constitute the WPs. It is easier, more intuitive, and more operationally effective to pull the chain by improving real-world WPs than it is to push the chain by improving abstract processes.

The Capability Waypoint Matrix

Robert Jacob, the Head of the Aviation Safety Department at the Atlantic Test Range at the Naval Air Station (NAS) Patuxent River, and Ron Abler developed the concept of displaying and tracking progress in the department's implementation of CMMI with a two-dimensional matrix, called a Capability Waypoint Matrix (CWM). Abler presented the CWM at a Software Engineering Process Group (SEPG) [2] meeting where the SEI had solicited ideas for simplifying the CMMI. A panel of CMMI sponsors, CMMI instructors, and SCAMPI leads peer-reviewed the CWM and declared it to be CMMI-compliant.

The Aviation Safety Department rolled out their CWM in October, 2007, and in 2008 published their T-Risk model [3], which was the first known implementation of CMMI in an operational aviation safety environment.

As the term *matrix* implies, a CWM is simply an array of rows and columns (see Figure 1). Each cell that is defined by the intersection of a single row and column is called a waypoint. The CWM is a snapshot of the work-product improvement status at a specific moment in time. In aviation, a waypoint is a point in physical space defined by latitude, longitude, altitude, and time of passage. In the CWM, a waypoint is defined by process name, effectiveness, efficiency, and date/time of the snapshot (i.e., evaluation). The rows and columns arrange the WPs in the structure defined by the CPI model in use.

While it is true that the CWM can be used to support any PI methodology that has artifacts (or WPs), the following description is based on the CMMI model [4], which is the methodology that VH-IS uses.

A CWM is generated as a spreadsheet for each CMMI process area in the organization's profile. Figure 1 depicts a simplified CWM for the risk management process area. The Y-axis (represented by the rows) charts overall effectiveness, and the X-axis (represented by the columns) charts overall efficiency. In CMMI, effectiveness (defined as simple performance) is defined by the achievement of specific goals (SGs). Efficiency (i.e., better, faster, cheaper, smarter) is defined by fulfillment of the generic goals. Therefore, in the CWM, the rows are populated by specific practices (SPs) and the columns by the generic practices (GPs). Thus, columns A and B of this CWM hold the risk management SGs and practices, while rows D through P hold the generic practices. Column C holds the WP (i.e., direct artifact) that results from each specific practice (these are what the SCAMPI team looks for). Since Stealth CPI tracks and manages WPs rather than processes, it is important that each row hold only one WP. If a SP generates more than one WP, add a row or rows as necessary to accommodate them. WPs tend to be organization-specific, so Figure 1 refers to them generically as WP 1.1 through 3.2.

Examples of Risk Management WPs might be a risk list for WP 2.1 and a fully categorized and prioritized risk list for WP 2.2. WP 3.1 would obviously be mitigation plans. If there are more than one, they can be designated as 3.1a, 3.1b, etc. WP 3.2 might be periodic reports that track and document the implementation of each mitigation plan.

Once a CWM has been completed to this point (filled in with SPs, GPs, and WPs), the simple secret of Stealth CPI becomes apparent. It is so simple that it sounds trivial. All that is required to achieve PI is to apply each GP, one at a time, to each WP and track the status of so doing in each waypoint. That status can be represented textually (e.g., excel-

Figure 1: *Sample Capability Waypoint Matrix (for the Risk Management Process Area)*

B27

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1				PERFORM	MANAGE										DEFINE	
2				GP 1.1	GP 2.1	GP 2.2	GP 2.3	GP 2.4	GP 2.5	GP 2.6	GP 2.7	GP 2.8	GP 2.9	GP 2.10	GP 3.1	GP 3.2
3				Perform Practices	Establish Policy	Plan the Process	Provide Resources	Assign Responsibility	Train the People	Manage Configurations	Involve Stakeholders	Monitor and Control	Evaluate Adherence	Review Status	Establish a Defined Process	Collect Improvement Information
4	SG 1	Prepare	Work Product													
5	SP 1.1	ID Risk Sources & Categories	WP 1.1													
6	SP 1.2	Define Risk Parameters	WP 1.2													
7	SP 1.3	Establish RSKM Strategy	WP 1.3													
8	SG 2	Identify and Analyze Risks														
9	SP 2.1	Identify Risks	WP 2.1													
10	SP 2.2	Evaluate, Categorize, Prioritize Risks	WP 2.2													
11	SG 3	Mitigate Risks														
12	SP 3.1	Develop Mitigation Plans	WP 3.1													
13	SP 3.2	Implement Mitigation Plans	WP 3.2													

	Direct Artifacts	Indirect Artifacts	Weaknesses
Fully Implemented	Present & adequate	At least one exists	None
Largely Implemented	Present & adequate	At least one exists	One or more
Partially Implemented	Absent or inadequate	One or more	One or more
Not Implemented	None	None	One or more
Not Yet	Not Yet	Not Yet	Not assessed yet
Not Required	Not required	Not required	Not assessed

Blank | CAR | DAR | IPM | MA | OID | OPD | OPF | OPP | OT | PI | PMC | PP | PPQA | QPM | RD | REQM

lent, good, inadequate), numerically (e.g., 1 through 10), or graphically (e.g., green, yellow, and red), as desired. The CWM in Figure 1 uses colors to denote status in a manner similar to the SCAMPI.

The technique of Stealth CPI starts with the waypoints in column D. If it can be demonstrated that a WP simply exists and that its indirect artifacts (e.g., memos, meeting minutes, emails, etc.) demonstrate that it is in regular use, then its waypoint in column D can be filled in with a satisfactory status. Once all the SPs in a process area have satisfactory marks in column D of the CWM, it can be said that the organization is minimally effective in that process area (i.e., Capability Level 1 "Performed").

Admittedly, higher capability levels are more difficult to achieve than merely demonstrating the existence of WPs, but the Stealth CPI technique remains just as simple at all capability levels: Apply each GP, one at a time, to each WP and improve that WP as necessary to comply with the GP. Take, for example, a mitigation plan, WP 3.1 (in row 12, column C). The waypoint under GP 2.5, Train the People (row 12, column I) would contain a satisfactory mark if it can be shown that the employee(s) who develop mitigation plans are properly trained to do so. Similarly, the waypoint under GP 2.6, Manage Configurations would hold a "Not Applicable" mark if the mitigation plan was not a configuration item (CI). Since it is likely that a mitigation plan would be a CI, the waypoint in column J would hold a satisfactory grade if the mitigation plan shows evidence of configuration management, such as a current document version number.

One can see that the CWM tracks both the simple existence (effectiveness) and the goodness of that WP (efficiency) relative to the discriminators required by whatever standard an organization chooses to use (such as the GPs in CMMI). It is the CWM that enables Stealth CPI to achieve PI, one WP at a time.

Work Folders

Once the processes, their related activities, and the resulting WPs have been mapped onto the CWM, it becomes possible to begin improving processes by directing the desired improvement in the organization's WPs.

Take GP 2.6, Manage Configurations, for example: Every WP (i.e., each row) in the CWM has its waypoint in the GP 2.6 column. If a WP is a configuration item (i.e., appears on the configuration item list, itself a WP), then Stealth CPI expects that evidence of configuration management will be reflected in the WP. In the case of a recurring report, the *improvement* might be the simple addition of a document version or control number. Improvement in WPs are managed through the use of work folders, which completely define the *who*, *what*, *when*, *where*, *why*, and *how* of each WP.

The goal of a work folder is to provide staff members with all the information and tools necessary to produce WPs of the desired quality. As appropriate to each WP, a work folder may contain a template, a tailoring guide, criteria for use, a process or activity diagram, complete instructions (if not contained in the template itself), perhaps a PI Indicator Description, and even the actual training materials (or pointers to the training) necessary for proper use and delivery. In a nutshell, the work folder completely defines the activity or activities that generate the WP. In total, the work folders implement the processes of the organization in an immediately usable form.

"Our staff does not have to be specifically trained in CMMI or even conversant with PI theory, concentrating on doing what they do best: generating the highest-quality WPs possible."

Stealth CPI in the Program Office

VH-IS is adopting the Program Management Office (PMO) approach of consolidating functions and standardizing methodologies and templates for use in the management and delivery of projects. This new approach will be the prototype for Stealth CPI. If successful, Stealth CPI will be implemented for new projects and eventually retrofitted throughout the organization. Stealth CPI will be the basis for re-use, wherever possible, of PMO-like processes and WPs. VH-IS has selected the continuous representation of CMMI with a tailored profile consisting of six high-priority process areas: project planning, project monitoring and control, requirements development, requirements management, configuration management, and risk management.

The first step was to generate a CWM for each process area by listing the SPs in the rows, and the GPs in the columns. The next step was to map the WPs from NAVAIR's SETR (entry and exit criteria) to their related SPs. This involved adding some practices or activities to account for non-CMMI WPs required by the SETR as well as adding some new WPs expected in the CMMI but not called for in the SETR.

After each individual CWM has been fully populated (such that every WP maps to a single practice or activity and every practice or activity maps to a unique WP), the work folders for each WP can be created and placed in a shareable repository.

Once a work folder has been completed and made available to staff members on a project-by-project basis, the VH-IS can track, manage, and ultimately fulfill all of the requirements of the governing SETR in a CMMI-compliant manner by simply assigning the WPs that fulfill the entry and exit criteria of the SETR (plus supporting CMMI-specific WPs, as necessary). From this point on, our ultimate goal of constant PI can be achieved through regular WP improvement as long as each improvement is defined and facilitated by the tools in the concomitant work folders. Our staff does not have to be specifically trained in CMMI or even conversant with PI theory, concentrating on doing what they do best: generating the highest-quality WPs possible.

In summary: Contrary to classic CPI, we will employ and improve our existing WPs; established processes and their improvement will be the consequent by-products. The CMM will serve as our tool and our map.

Early Success Indicators

At VH-IS, we are on the verge of declaring success at Capability Level 1 for our profile. As soon as we have mapped an existing WP (direct artifact) to each SP and can demonstrate their active use with indirect artifact(s), we can claim Level 1 because we can prove that we are performing each specific practice. Considering that, we will have reached Level 1 without requiring the very time-consuming and (unfortunately) distracting SEPG. In fact, we will have achieved

this with only the part-time involvement (16 hours per week) of the standards engineer and a couple of hours per week of the team lead's time—a definite cost-avoidance. Furthermore, we have gotten this far without requiring any formal CMMI training of our staff—a definite cost-savings. This is an early indicator that we can continue this technique through Levels 2 and 3, and we should be able to do so very cost-effectively, while imposing little or no process-improvement distraction into the equation.

Also, in the course of reaching Level 1, we will have mapped our SPs to the NAVAIR-mandated technical review system, thereby killing two birds with one stone: We have demonstrated the feasibility of implementing a technical review system that is intrinsically CMMI-compliant through common WPs. We consider this to be a necessary milestone toward the success of our initially stated ultimate goal, which is to structure our WPs so that our people can be best-practices compliant just by doing their jobs.

Ten Steps to Successful Stealth CPI

If you plan on starting to utilize Stealth CPI in your organization, here are 10 essential steps to success:

1. Create a CWM template for each process area[1].
2. List each activity within the process on its own row in column A and B. In CMMI, these are SPs.
3. List the title of each activity's WP in column C.
4. If an activity generates more than one WP, add a row for each WP, repeating the activity name in columns A and B, and the name of the artifact in column C. In column D, insert a word or phrase that will document the simple existence of each artifact.
5. Determine the discriminators that will be used to evaluate the incremental improvement of the process. In CMMI, these are the GPs. Place the name of each discriminator in the top row of each column, beginning with column D.
6. For each WP, assign an owner/manager who is responsible for its maintenance and upkeep.
7. Define a complete work folder for each artifact or group of artifacts that represents a discrete WP.
8. Conduct internal audits (gap analyses) of the artifacts and WPs, recording the status of each in the appropriate waypoint, starting with column D (*exists*) and denoting each qualifying waypoint under the discriminators, as appropriate.
9. Use the results of the audits to evaluate the overall PI program and to continue improving the organization's WPs.
10. When all waypoints in a process are satisfactory for the desired next level of improvement, DECLARE VICTORY!◆

Software Defense Application

Defense organizations will find that Stealth CPI is much more intuitive and cost-effective than traditional CPI because it approaches the problems from the perspective of real-world work products rather than abstract processes. This article steps the reader through the set-up and implementation of Stealth CPI with the use of its central tool, the Capability Waypoint Matrix. Stealth CPI saves time and money over more conventional approaches because it requires less process-specific training, fewer people dedicated to the CPI project itself, and therefore less overhead to achieve the same results. Better-managed WPs foster better reuse, result in more efficient implementation, and are easier to improve than abstract processes.

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Note

1. Contact Ron Abler by e-mail for free-of-charge, ready-to-use sets of CWMs.

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